# IMPLEMENTATION OF ENVIRONMENTAL COMPLIANCE FOR OPERATING RADIOACTIVE LIQUID WASTE SYSTEMS AT THE OAK RIDGE NATIONAL LABORATORY

James H. Hooyman
Waste Management and Remedial Action Division
Oak Ridge National Laboratory
Building 3042, MS 6060
P.O. Box 2008
Oak Ridge, Tennessee 37831-6021

## ABSTRACT

This paper addresses methods being implemented at the Oak Ridge National Laboratory (ORNL) to continue operating while achieving compliance with RCRA requirements for low level liquid waste (LLLW) underground storage tank systems. A Federal Facility Agreement for the Oak Ridge Reservation was implemented on January 1, 1992, by the United States Environmental Protection Agency (EPA), DOE, and the Tennessee Department of Environment and Conservation (TDEC). The agreement ensures that environmental impacts resulting from operations at the Oak Ridge Reservation are investigated and remediated to protect the public health, welfare, and environment. This agreement differs from previous compliance arrangements which address inactive facilities. ORNL is a fully functional multi-disciplinary nuclear research facility. As a consequence of the research activities, solid and liquid radioactive wastes have been generated in varying amounts over time. The LLLW has been accumulated and stored in 96 below-grade collection tanks interconnected by miles of underground piping. The LLLW system was designed to minimize radiation exposure and is not amenable to standard verification methods. Much of the LLLW system was installed more than 30 years ago. This paper summarizes the strategy that ORNL is using to implement this agreement, such as remote inspection, leak detection methods, integrity assessments, and development of alternate collection and treatment techniques.

## INTRODUCTION

This paper addresses methods being implemented at the Oak Ridge National Laboratory (ORNL) to continue laboratory research and development activities while achieving compliance with new standards for liquid low level waste (LLLW) underground storage tank systems. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) states that the government's clean up activity must be conducted in accordance with the National Contingency Plan (NCP). The NCP details response procedures including immediate removal and long term remedial actions. CERCLA also authorizes the Environmental Protection Agency (EPA) to designate sites requiring remedial action on the National Priorities List (NPL). The Superfund Amendment and Reauthorization Act (SARA) amended CERCLA by adding provisions specifically aimed at Federal Facilities and by increasing EPA enforcement authority.

The CERCLA required that the Department of Energy (DOE) execute a Federal Facility Agreement (FFA) with the (EPA) after listing of the Oak Ridge Reservation (ORR) on the National Priorities List (NPL). The ORR was put on the NPL December 21, 1989. Effective May 13, 1991, DOE entered into such an agreement. The FFA for ORR became effective January 1, 1992 among the EPA, DOE, and the Tennessee Department of Environment and Conservation (TDEC). The agreement establishes a procedural framework and schedule for developing, implementing, and monitoring response action at the site in accordance with CERCLA, the NPL, the National Environmental Policy Act (NEPA), and Tennessee law. The agreement ensures that environmental impacts resulting from operations at the Oak Ridge Reservation are investigated and remediated to protect the public health, welfare, and environment. This FFA differs from other compliance agreements in that it addresses both inactive and active systems, as opposed to other CERCLA agreements which address inactive systems only.

Although the FFA addresses the entire Oak Ridge Reservation, specific requirements are defined for the radioactive LLLW collection and storage tanks and associated piping at ORNL. The objective of the FFA as it relates to the ORNL tank systems is to ensure that tank system structural integrity, LLLW containment, leak detection capability, and LLLW source control are maintained until final remedial action. The FFA requires that leaking LLLW tank systems be immediately removed from service, and that active tank systems be doubly contained, cathodically protected, and have leak detection capability. LLLW tank systems that do not meet these requirements are to be either upgraded or replaced, but can remain in service if they are structurally sound, do not leak, and are scheduled for upgrade or replacement.

This paper presents the strategy used to allow ORNL operations to continue while upgrading the tank systems to FFA compliance requirements.

## ORNL BACKGROUND

ORNL is a multi-disciplinary research facility operated for the Department of Energy by Martin Marietta Energy Systems, Inc. ORNL began operation in 1943 as part of the Manhattan Project. The original mission was to develop a prototype graphite reactor and reprocess the reactor fuel for plutonium recovery. Following World War II, the primary functions were fuel reprocessing research, radioisotopes development, and testing of nuclear reactor concepts. ORNL's current mission is to conduct research and development activities for DOE and other government agencies as well as private industry and institutions. Currently these research efforts are focused in the areas of:

1. magnetic fusion,
2. nuclear fission,
3. biological and environmental basic research,
4. conservation and renewable energy,

5. fossil energy, and

6. basic research in physical science.

As a result of current and past research activities, solid and liquid radioactive wastes have been generated in varying amounts over time. The liquid radioactive waste has been accumulated and stored in 96 below-grade collection and transfer tanks interconnected by miles of underground piping. Although the LLLW system was designed to minimize radiation exposure, it is not amenable to standard verification methods due to potential radiation exposure when in proximity to the system.

LLLW originates from radioactive liquid discarded into sinks and drains in research and development laboratories, processing facilities, nuclear reactors, and radioisotope production. Current LLLW acceptance limits are characterized as having an activity greater that the trace levels permitted in process waste and less than 2 Ci/gal of Strontium-90 equivalent and less than 100 Nci/g of alpha-emitting transuranic elements.

## LLLW SYSTEM OVERVIEW

The LLLW tanks and piping system is an assemblage of tanks, associated transfer pipelines, and ancillary equipment designed for collecting, neutralizing, concentrating, and storing wastes prior to disposal. The bulk of the LLLW tanks and transfer lines are buried underground for purposes of radiation shielding. The system was originally 'designed to handle waste solutions with maximum activity of 20 Ci/gallon. The current acceptance limit is 2 Ci/gallon.

The active LLLW system consists of the following major parts:

- small tanks located near source buildings;
- waste collection vehicles;
- interim collection tanks, transfer lines, and pumping stations;
- waste evaporators and associated storage tanks;
- eight storage tanks for storage of the evaporator concentrates.

The LLLW handling system consists of 96 tank systems. Fifty five tanks have been removed from service, and 41 remain in active usage. The LLLW solutions are accumulated at source buildings in collection tanks and sent to the ORNL evaporator facility for an approximate 30 to 1 concentration. The concentrate is then transferred via pipelines to 8 storage tanks.

Most of the LLLW tank and piping system was installed more than 30 years ago. The initial system and subsequent modifications were designed to minimize radiation exposure to the LLLW system users and operators. The LLLW tanks system includes unvalved, gravity-drained transfer pipelines, single and double contained tanks, pressure transfer pipelines from the collection tanks to the central waste collection header, and remote handling capability to minimize personnel exposure. As-build drawings for most of the older tank systems do not exist. Over the years, tank systems were abandoned as their integrity was breached or as programs were terminated. As new tank systems were installed over the past 10 to 15 years, some secondary containment features and improved leak detection were incorporated.

The tank system drain piping is typically a stainless steel, singly contained pipe with a nominal diameter of 2 inches or less, that drains by gravity to an area collection tank. The collection tanks are usually stainless steel tanks located in a service building with capacities less than 3000 gallons. These tanks are periodically emptied to the central treatment system using steam jets and pumps. The discharge piping typically consists of stainless steel pipelines with a nominal diameter of 2 inches. These lines are used for batch transfers of LLLW, under pressure on an as-needed basis, to maintain inventory control at the collection tanks and to transfer LLLW to the central LLLW system for evaporation and storage.

## STRATEGY FOR MEETING THE FFA OBJECTIVES

### Organizational Structure

One DOE Headquarters and 2 DOE-Oak Ridge divisions under the Assistant Manager for Environmental Restoration and Waste Management have primary responsibility for the FFA. Two corresponding Martin Marietta Energy Systems Inc. organizations have primary responsibility for FFA planning and implementation, the Energy Systems Environmental Restoration Division and the Waste Management and Remedial Action Division.

### FFA Configuration Control Board

An FFA configuration control board was established to monitor and control pertinent aspects of the ORNL LLLW system to ensure compliance with the FFA. The board serves as an advisory group to provide guidance on system changes, evaluations for FFA compliance, and changes in construction projects. The board is comprised of representatives from the Waste Management and Remedial Action Division, Engineering, Chemical Technology, Environmental Compliance, Quality Assurance, and DOE Oak Ridge Waste Management personnel.

### FFA Working Team

An ORNL FFA response plan was developed with an ORNL FFA working team of multi-disciplinary support from various ORNL organizations and divisions. The team meets regularly to provide coordination for the planning and implementation of FFA compliance activities. The LLLW tank systems were evaluated for FFA categorization, risk assessments, upgrade and replacement plans, containment, waste characteristics, age, confidence in historical tank system data, strategic importance to ORNL, and FFA documentation requirements.

The FFA defines 4 categories of tank systems,

1. category A;new or replacement tank systems with secondary containment,
2. category B;existing tank systems with secondary containment,
3. category C;tank systems without secondary containment, and
4. category D;tank systems that are removed from service.

The FFA working team categorized the tank systems and formulated plans and schedules to bring the ORNL LLLW tank systems into full FFA compliance by 2002.

### Technical Advisory Group (TAG)

The TAG is a group of experts who are nationally recognized in technical fields that relate to the FFA activities. The TAG was established to provide independent technical and managerial oversight and consultation to ensure that the ORNL FFA program plans meet the FFA requirements and

it protects health safety and the environment. The TAG's scope includes oversight of the total ORNL FFA programmed review of technical approach and plans for technical adequacy and safety. The TAG operates as an independent group that meets about 3 times a year. The TAG issues formal reports after each meeting to document its findings and recommendations.

### Integrated LLLW System Strategy

Due to the division of organizational responsibilities and funding sources, FFA compliance planning and implementation is organized on the basis of tank systems in service (category A-C) and tank systems removed from service (category D). The FFA working team functions as the coordinating body to integrate FFA activities between these 2 areas.

ORNL currently has no category A tanks. The category B tank systems in FFA compliance are being documented to show that they meet the FFA requirements. A comprehensive program is underway to upgrade or replace category C tank systems not in FFA compliance. The category D tank systems that were removed from service are being investigated and remediated through the CERCLA process.

The category B tank systems were evaluated to show compliance to the FFA requirement for doubly contained tank systems. Documents were prepared and submitted to the FFA regulators for their concurrence that ORNL's category B tanks meet the FFA requirements.

Plans were prepared to replace or upgrade all non compliant category C tank systems that remain in service. Capital construction projects were initiated or modified to upgrade or replace tank systems to assure FFA compliance. Contingency plans were developed to assure continued ORNL operations after removal from service of leaking or potentially leaking systems. Per the FFA, plans and schedules were formalized and submitted to the FFA regulators for their approval.

Category D tank systems no longer needed by ORNL and tanks suspected of leaking were removed from service except for tank systems that cannot be shut down immediately due to health and safety risks associated with their shutdown. Risk assessments have shown that 3 singly contained active tank systems cannot be shut down without creating unacceptable risks to worker health and safety. However, continued operation of these tank systems will pose no immediate risk to human health or the environment. In accordance with the provisions of the FFA, these tank systems were identified and have been designated as Environmental Safety and Health (ES & H) systems that will remain in service. Risk assessments that form the basis for maintaining the ES&H tank systems in service were submitted to the FFA regulators.

## IMPLEMENTATION PLANS FOR FFA COMPLIANCE

Plans being implemented at ORNL to maintain FFA compliance include:

1. tank categorization,
2. tank system assessments for compliance verification,
3. tank system upgrades and replacements,
4. lek testing of tanks and pipelines for integrity verification to allow using the category C non compliant tank systems,
5. contingency planning and implementation to assure continued ORNL operations in the event of a leak,
6. fulfillment of the Environmental Restoration Program (ERP) acceptance requirements for category D inactive tank systems, and
7. FFA documentation submittals.

The required tank assessments and leak testing are complicated by the fact that the tank systems are not directly accessible due to the radioactivity associated with them. Remote inspections, decontamination, and repair procedures are being used.

### Tank Categorization

The ORNL LLLW tank systems have been evaluated and categorized by the FFA working team as follows:

- no Category A-new tanks,
- 30 Category B-secondarily contained tanks in use,
- 11 Category C-singly contained tanks in use, and
- 55 Category D-tanks that were removed from service.

The 30 category B active tank systems are either partially or fully in compliance with the FFA requirements for secondarily contained systems. The partially compliant tanks are being upgraded to meet the FFA requirements. The 11 category C active singly contained tank systems must be removed from service, but are allowed to remain in service temporarily if they can be shown not to leak until they are replaced. Thirty nine category D tanks are currently accepted into the ER program. Sixteen of the remaining category D tanks were removed from service but had not met the ERP transfer requirements on the effective date of the FFA. ORNL has initiated the transfer of these 16 tanks to the ERP.

### Tank System Assessments

The FFA requires that existing category B doubly contained tank systems must be evaluated to show that the secondary containment meets or can be retro-fitted to meet specific requirements for category B secondarily contained systems. These requirements include verification of the containment structural integrity, the ability to safely contain potential waste leaked from the tank systems, and have the capability of leak detection of the primary containment system. Each doubly contained tank system was evaluated by drawings and specifications review, determination of tank structural condition, evaluation of the LLLW contained in the tank, and evaluation of the overall tank containment system's ability to contain potential leakage. These secondary containment design demonstrations were submitted to the FFA regulators.

The FFA requires that existing category C singly contained tank systems be assessed for structural integrity and potential upset to the environment. The assessment also is required to show that there is no evidence of tank collapse, rupture, or failure prior to its removal from service or re-assessment. The structural integrity for the singly contained tanks includes periodic leak testing for continued verification that they do not leak.

These demonstrations of the secondary containment and the structural integrity assessments are complicated because visual inspection of much of the tank system is not possible because of the radioactivity involved. In some cases, remote television camera inspection is being used to assist in the verification of the tank integrity.

In preparing the assessments and subsequent upgrade or removal-from-service plan, it has been assumed that tank system assessments will show compliance or that repairs can

be made to maintain system operations until upgrade or replacement plans can be implemented. If leaks in the tank systems are identified, all programmatic inputs except for ES&H-related activities will be stopped, and the system will be repaired or replaced. The tank system may continue to collect non-programmatic wastes such as inleakage, inadvertent wastes from floor drains and sumps, and condensate collected in the off-gas ventilation systems during this period.

**Tank System Upgrades and Replacements**

The FFA contains requirements for tank systems that do not meet secondary containment criteria. The FFA requires a plan for removing from service all LLLW tank systems that cannot meet FFA criteria. Structural integrity assessments and leak testing are required for the category C tanks that remain in service. All the ORNL non compliant tank systems have upgrade or replacement projects planned, and are undergoing structural integrity assessments in compliance with the FFA.

Expense-funded projects, General Plant Projects (GPPs), and Line Item Projects (LIPs) are being planned and implemented to upgrade or replace the non compliant tank systems. Some of these projects require several years to implement; therefore, interim projects were initiated to upgrade some of the existing tank systems until full compliance can be achieved. Some of these projects will be implemented as expense-funded projects that can be initiated and executed within a shorter time frame and with more flexibility that the GPPs and LIPs.

GPPS are capital construction projects that have a total estimated cost less that $1.2 million. This limit is congressionally authorized, and the GPP funding level is established annually for ORNL. Each GPP is a stand-alone project and takes 4 to 5 years for completion.

LIPs are large capital construction projects with total estimated costs greater than $1.2 million. Each LIP is identified and authorized as a specific entry in the congressional budget approval process. Because of the complexity and magnitude of these types of projects, LIPs can take up to 10 years to complete; however, the LIP life cycle averages 7 years overall--three years for project planning and four years for execution. The majority of the LLLW upgrade and replacement projects fall into this category.

**Leak Test Program**

The FFA allows category C tank systems that do not meet secondary containment standards to remain in service until the system can be upgraded or replaced, as long as they are structurally sound and do not leak. Therefore in conjunction with the tank structural integrity assessments, leak testing is being performed for all the category C tank systems and all of the category B tanks that are not fully FFA compliant. Three methods of leak testing are being developed and implemented for the following 3 distinct tank system components:

1. gravity fed drain piping from the LLLW source to a collection tank,
2. collection tank, and
3. the pressurized discharge piping from the collection tank to the central waste collection header.

A volume balance method is being used for the tanks, where the tank levels are continually monitored over a period of time. For the gravity lines, liquid is introduced into the pipe line at a measured rate and the associated tank level is monitored to verify that what went into the pipe came out into the tank. The pressure pipe lines are leak tested by pressuring the pipes and monitoring the pressure over a period of time for pressure drop.

The FFA does not define specific leak test criteria for LLLW tank systems. The planned criteria is based on current leak detection technology and technical standards from relevant portions of federal regulations for underground storage tanks. This ensures that performance requirements for the leak detection methods described in the ORNL FFA plans are technically achievable and that the degree of environmental protection provided by the plan is consistent with other federal regulations.

Leak testing of underground tanks and pipelines in the petroleum industry and for other hazardous substances is well established; however, some issues must be considered that are unique to the ORNL LLLW system. Leak testing of unvalved piping and tanks which are under negative pressure for containment purposes, for example, requires adaptation of current technology and development of some new leak-testing technology. In addition, testing is constrained by radiological exposure concerns, severely limited access to the system, disposal of secondary wastes produced, and limitations in modifying the system. The leak testing plan is the "volume balance" method, where tank levels are monitored for variance over a period of time, such as 24 hours.

**Contingency Plans**

ORNL is implementing contingency studies and projects to assure continued operations in the event of a leak. Each non compliant tank system was evaluated for potential for leakage, replacement or upgrade schedule, and period of vulnerability if a leak is detected. To preclude shutdown, ORNL is implementing interim expense-funded action for key ORNL LLLW tank systems including; local and area collection and transfer of waste to the central LLLW system, source treatment, waste reduction, process elimination, and program shutdown. Options being implemented for interim action include construction of interim waste bottling and trucking stations for collection and transport of waste, administrative actions to keep the systems in interim service, tank system modifications for interim use, alternative LLLW treatment or collections systems, revision of operating documents, and rerouting some transfer lines.

**Environmental Restoration Acceptance Requirements**

The 16 category D tanks that were removed from service, but not accepted by the ERP, when the FFA became effective are being turned over to the ERP for remediation. The ERP acceptance policy defines a multi step process for transferring management responsibilities for surplus facilities.

- First, application is made by submitting available descriptive status and assessment information for each tank system.
- As part of the acceptance package, the waste that resides in the tanks must be characterized to assist the ERP in determining remediation and schedules.
- On the basis of the information submitted, a memorandum of agreement is issued that establishes the requirements the tank systems must meet for the actual acceptance into the ERP.

Since the LLLW is radioactive, special sampling and analysis procedures were developed and are being implemented.

**FFA Document Submittals**

Several document submittals are required by the FFA. Within 90 days of the effectivity of the FFA, ORNL submitted its FFA compliance plans and schedules. Other document submittals include; structural integrity assessments, secondary containment design demonstrations, design installation assessments for newly installed piping systems, leak test plans and schedules, and periodic status reports.

## SUMMARY

ORNL has submitted FFA compliance plans, design demonstrations for the category B tanks, leak test plans, and initiated structural integrity assessments, leak testing of tanks, waste characterization of the category D inactive tanks, interim bottling and trucking operations and alternate LLLW treatment development. In addition, ORNL has initiated and modified several line item projects, general plant projects, and expense related projects to bring the LLLW collection, transfer and treatment system into full FFA compliance by the year 2002. The ORNL FFA working team meets routinely with the FFA regulators to keep them fully cognizant of the compliance implementation plans and status, and jointly resolves uncertainties and concerns that emerge. In addition, ORNL submits FFA required documentation to describe the ORNL compliance plans, schedules, methodology, and status. With the working relationship established among the DOE, TDEC, and the US-EPA, ORNL is confident that its operations can continue while implementing FFA compliance activities.